

WHAT IS CLAIMED IS:

1 1. A method of operating a torque transmitting
2 apparatus which receives torque from a rotary output element
3 of a prime mover and transmits torque to a rotary input
4 element of an automatic transmission in a power train of
5 a vehicle, wherein a hydrokinetic torque converter is arranged
6 to transmit torque between the output and input elements
7 in parallel with a slip clutch and wherein the magnitude
8 of torque being transmitted by the clutch is selectively
9 variable by a computerized regulating unit, comprising
10 the steps of regulating the transmission of torque by the
11 clutch as a function of the magnitude of torque being transmitted
12 by the output element of the prime mover including ascertaining
13 and adaptively applying to the clutch a variable force
14 for the transmission of a predetermined torque by the clutch
15 with attendant automatic selection of a minimum slip between
16 a torque receiving and a torque transmitting part of the
17 power train; and carrying out a compensation, particularly
18 long-range compensation, for eventual differences between
19 the predetermined and actual torques being transmitted
20 by the clutch.

1 2. The method of claim 1, wherein the torque to
2 be transmitted by the clutch as a function of the RPM of
3 the output element of the prime mover is ascertained by
4 the regulating unit in accordance with the equation

$$M_{\text{clutch}} = k_{\text{me}} \cdot k_{\text{corr}} \cdot (M_{\text{pm}} + M_{\text{corr pm}}) + M_{\text{corr wu}}$$

5 wherein M_{clutch} is the torque to be transmitted by the clutch,
6 k_{me} is a torque dividing factor which is at least substantially
7 constant within the entire operating range of the power train,
8 k_{corr} is a factor for correction of multiplicative errors,
9 $M_{\text{corr pm}}$ is correction torque to compensate for errors added
10 to the M_{pm} , and $M_{\text{corr wu}}$ is correction torque compensating
11 for errors added to the clutch torque M_{clutch} , said minimum
12 slip between torque receiving and torque transmitting parts
13 of the power train being automatically selected as a function
14 of said torque dividing factor and long-range compensation
15 for any departures of actual torques from the predetermined
16 torques being carried out in dependency upon the correction
17 factor k_{corr} and correction torques $M_{\text{corr pm}}$ and $M_{\text{corr wu}}$.

1 3. The method of claim 2, wherein the torque dividing
2 factor k_{me} is a function of the RPM of the rotary output element.

1 4. The method of claim 2, wherein the torque dividing
2 factor k_{me} is a function exclusively of the RPM of the rotary
3 output element.

1 5. The method of claim 2, wherein the torque dividing
2 factor k_{me} is a function of the RPM and of the torque being
3 transmitted by the rotary output element.

1 6. The method of claim 1, wherein the torque dividing
2 factor k_{me} is a function of the RPM and torque being trans-
3 mitted by the prime mover.

1 7. The method of claim 1, wherein the magnitude of
2 the torque being transmitted by the clutch is variable by a
3 pressure differential between two bodies of a hydraulic fluid
4 one of which is confined in a first compartment between a
5 housing of the torque converter and the clutch and the other
6 of which is confined in a second compartment between the
7 housing and the clutch.

1 8. The method of claim 1, wherein the prime mover
2 is a combustion engine and the operating condition of the
3 power train is a function of at least one of a plurality of
4 variable parameters including (a) the RPM of the rotary
5 output element and the position of a throttle control lever
6 of the vehicle, (b) the RPM of the rotary output element and
7 the rate of admission of fuel to the engine, (c) the RPM
8 of the rotary output element and the subatmospheric pressure
9 in a suction pipe of the engine, and (d) the RPM of the
10 rotary output element and the duration of fuel injection into
11 the engine.

1 9. The method of claim 1, wherein said regulating
2 step includes shifting from the transmission by the clutch
3 of a first torque to the transmission of a different second
4 torque with a delay which is a function of a variable parameter
5 denoting the division of torque being transmitted by the rotary
6 output element of the prime mover into a first torque being
7 transmitted by the torque converter and a second torque being
8 transmitted by the clutch.

1 10. The method of claim 9, wherein the variable
2 parameter is a pressure differential between two bodies of
3 fluid in the torque converter at opposite sides of a pressure
4 plate of the clutch.

1 11. The method of claim 9, wherein the variable
2 parameter is variable as a function of a difference between the
3 RPM of the rotary output element and the RPM of the rotary
4 input element.

1 12. The method of claim 9, wherein the variable
2 parameter is variable as a function of a gradient of the RPM
3 of the rotary output element.

1 13. The method of claim 9, wherein the variable
2 parameter is a pressure differential between two bodies of
3 hydraulic fluid in the torque converter at opposite sides
4 of a pressure plate of the clutch, the pressure differential
5 being variable by one of (a) a PI regulator and (b) a PID
6 regulator.

1 14. The method of claim 13, wherein the variation
2 of pressure differential by the one regulator can be
3 unequivocally defined by a non-analytical technique.

1 15. The method of claim 1, wherein the magnitude
2 of torque being transmitted by the clutch is variable by a
3 pressure differential between two bodies of hydraulic fluid
4 confined in a housing of the torque converter at opposite
5 sides of a pressure plate of the clutch and the pressure
6 differential is variable as a result of scanning a
7 characteristic curve and utilizing the thus obtained signals
8 to determine differences between actual and desired pressure
9 differentials, said regulating step further comprising
10 eliminating said differences by establishing an I return
11 flow of fluid from one of the compartments into the other
12 of the compartments, the variation of pressure differential
13 being unequivocally definable by a non-analytical technique.

1 16. The method of claim 15, wherein the signals are
2 generated as a result of variable flow of fluid between the
3 two bodies of fluid through an adjustable valve.

1 17. The method of claim 1, wherein the magnitude
2 of torque being transmitted by the clutch is variable by a
3 pressure differential between two bodies of hydraulic fluid
4 confined in the torque converter at opposite sides
5 of a pressure plate of the clutch and the pressure differential
6 is variable by one of (a) a PI regulator, (b) an I regulator
7 and (c) a PID regulator.

1 18. The method of claim 17, wherein signals are
2 generated as a result of variable flow of hydraulic fluid
3 between the two bodies of fluid as a function of one of
4 (a) a duty factor and (b) a fluid flow through an adjustable
5 valve, the variation of pressure differential being
6 unequivocally definable by a non-analytical technique.

1 19. The method of claim 1, wherein the step of
2 carrying out compensation includes monitoring the actual
3 torques being transmitted by the clutch and comparing the
4 monitored actual torques with reference values.

1 20. The method of claim 1, wherein the step of carrying
2 out compensation includes computing the torque being transmitted
3 by the torque converter on the basis of the characteristics
4 of the torque converter and determining the actual ratio of
5 torques being transmitted by the torque converter and the
6 clutch.

1 21. The method of claim 1, wherein the torque to be
2 transmitted by the clutch as a function of the RPM of
3 the output element of the prime mover is ascertained by
4 the regulating unit in accordance with the equation

$$M_{\text{clutch}} = k_{\text{me}} \cdot k_{\text{corr}} \cdot (M_{\text{pm}} + M_{\text{corr pm}}) + M_{\text{corr wu}}$$

6 wherein M_{clutch} is the torque to be transmitted by the clutch,
7 k_{me} is a torque dividing factor which is at least substantially
8 constant within the entire operating range of the power train,
9 k_{corr} is a factor for correction of multiplicative errors,
10 M_{corr} is correction torque to compensate for errors added
11 to the M_{pm} , and $M_{\text{corr wu}}$ is correction torque compensating
12 for errors added to the clutch torque M_{clutch} , said minimum
13 slip between torque receiving and torque transmitting parts
14 of the power train being automatically selected as a function
15 of the torque dividing factor k_{me} and long-range compensation
16 for any departures of actual torques from the predetermined
17 torques being carried out in dependency upon the correction

CLAIM 21, CONTINUED

18 factor k_{corr} and correction torques $M_{\text{corr pm}}$ and $M_{\text{corr wu}}$,
19 the differences between the actual and predetermined torques
20 being transmitted by the clutch being attributable to at least
21 one of (a) multiplicative errors ($k_{\text{corr}} \neq 0$, $M_{\text{corr pm}} = 0$,
22 $M_{\text{corr wu}} = 0$), (b) errors additive to prime mover torque
23 ($k_{\text{corr}} = 0$, $M_{\text{corr pm}} \neq 0$, $M_{\text{corr wu}} = 0$), (c) errors additive
24 to the clutch torque ($k_{\text{corr}} \neq 0$, $M_{\text{corr pm}} = 0$, $M_{\text{corr wu}} \neq 0$),
25 (d) multiplicative errors and additive errors to prime
26 mover torque ($k_{\text{corr}} \neq 0$, $M_{\text{corr pm}} \neq 0$, $M_{\text{corr wu}} = 0$),
27 (e) errors multiplicative and additive to prime mover torque
28 ($k_{\text{corr}} \neq 0$, $M_{\text{corr pm}} = 0$, $M_{\text{corr wu}} \neq 0$) and (f) errors
29 multiplicative of and additive to prime mover torque and
30 clutch torque ($k_{\text{corr}} \neq 0$, $M_{\text{corr pm}} \neq 0$, $M_{\text{corr wu}} \neq 0$), said
31 step of carrying out compensation taking place with a time
32 constant of several seconds to thus impart to the step of
33 carrying out compensation a purely adaptive character.

1 22. The method of claim 1, wherein the prime mover
2 is operable at a plurality of speeds and further comprising
3 the step of utilizing signals denoting a desired acceleration
4 of the prime mover by an operator of the vehicle to increase
5 the slip of the clutch as a result of a reduction of a factor
6 k_{me} denoting the division of torque being transmitted by the
7 rotary output element into first and second torques respectively
8 transmitted by the torque converter and the clutch with
9 attendant establishment of additional spare torque transmittable
10 by the torque converter.

1 23. The method of claim 1, wherein the transmission
2 has a plurality of drive ratios and said regulating step
3 includes utilizing the slip of the clutch at each of said
4 drive ratios as a primary factor and the efficiency of the
5 torque converter as a secondary factor for the transmission
6 of torque from the rotary output element to the rotary input
7 element to thus permit the utilization of a torque converter
8 operating with a high stall speed and having a wide torque
9 conversion range.

24. The method of claim 1, wherein the transmission has a plurality of speed ratios and said regulating step includes utilizing the slip of the clutch at each of said speed ratios as a primary factor and the efficiency of the torque converter as a secondary factor for the transmission of torque from the rotary output element to the rotary input element to thus permit the utilization of a torque converter operating with a high stall speed and having a wide torque conversion range.

25. A method of operating a torque transmitting apparatus which receives torque from a rotary output element of a prime mover, such as a combustion engine, and transmits torque to a rotary input element of an automatic transmission in a power train of a vehicle, wherein a hydrokinetic torque converter is arranged to transmit torque between the output and input elements in parallel with a slip clutch, and wherein the magnitude of torque being transmitted by the clutch is variable by a monitoring unit in conjunction with a central computer unit and the application of force to, and hence the magnitude of torque being transmitted by, the clutch is selectively regulatable by the computer unit, comprising the steps of ascertaining the magnitude of torque to be transmitted by the clutch in dependency upon the operating

CLAIM 25, CONTINUED

15 condition of the power train in accordance with the equation

16
$$M_{\text{clutch}} = k_e \cdot k_{\text{corr}} \cdot M_{\text{pm}}$$

17 wherein $k_e = k_{\text{me}}$ denoting a torque dividing factor which is

18 at least substantially constant within the entire operating

19 range of the power train, k_{corr} is a correction factor,

20 M_{clutch} is the torque being transmitted by the clutch and

21 M_{pm} is the torque being transmitted by the rotary output

22 element of the prime mover, ascertaining the magnitude of

23 the force to be applied to the clutch for the transmission

24 of a predetermined torque, applying the thus ascertained

25 force to the clutch with attendant automatic selection of

26 the slip between the output and input elements as a function

27 of the torque dividing factor k_e and compensation for eventual

28 departures from the desired torque transmission, as a function

29 of the correction factor k_{corr} , due to the characteristics

30 of the selected power train.

1 26. A method of operating a torque transmitting

2 apparatus, particularly in a power train of a motor vehicle,

3 which receives torque from a rotary output element of a prime

4 mover, such as a combustion engine, and transmits torque to

5 a rotary input element of an automatic transmission, wherein

6 a hydrokinetic torque converter is arranged to transmit torque

7 between the output and input elements in parallel with a slip

CLAIM 26, CONTINUED

8 clutch, and wherein the magnitude of torque being transmitted
9 by the clutch is selectively variable by a monitoring device
10 in conjunction with a central computer unit, comprising the
11 steps of ascertaining the magnitude of torque M_{clutch} to be
12 transmitted by the clutch in dependency upon the operating
13 condition of the torque transmitting apparatus in accordance
14 with the equation $M_{\text{clutch}} = k_e \cdot k_{\text{corr}} \cdot M_{\text{pm}}$ wherein
15 $k_e = k_{\text{me}}$ denoting a torque dividing factor which is independent
16 of a characteristic field of the prime mover, k_{corr} is a
17 correction factor and M_{pm} is the torque being transmitted
18 by the prime mover, ascertaining the magnitude of the force
19 to be applied to the clutch for the transmission of a
20 predetermined torque, and applying the thus ascertained force
21 to the clutch with attendant automatic selection of the slip
22 between the output and input elements as a function of the
23 factor k_e and compensation for eventual departures from the
24 desired torque transmission, as a function of the correction
25 factor k_{corr} , due to the characteristics of the selected
26 power train.

1 27. A method of operating a torque transmitting
2 apparatus, particularly in a power train of a motor vehicle,
3 which receives torque from a rotary output element of a prime
4 mover, such as a combustion engine, and transmits torque to

CLAIM 27, CONTINUED

5 a rotary input element of an automatic transmission, wherein
6 a hydrokinetic torque converter is arranged to transmit torque
7 between the output and input elements in parallel with a slip
8 clutch, and wherein the magnitude of torque being transmitted
9 by the clutch is selectively variable by a monitoring device
10 in conjunction with a central computer unit, comprising the
11 steps of ascertaining the magnitude of torque M_{clutch} to be
12 transmitted by the clutch in dependency upon the operating
13 condition of the torque transmitting apparatus in accordance
14 with the equation $M_{\text{clutch}} = k_e \cdot k_{\text{corr}} \cdot M_{\text{pm}}$ wherein
15 $k_e = k_{\text{me}}$ denoting a torque dividing factor which is dependent
16 only upon the RPM of the output element of the prime mover,
17 k_{corr} is a correction factor and M_{pm} is the torque being
18 transmitted by the prime mover, ascertaining the magnitude of the
19 force to be applied to the clutch for the transmission of a
20 predetermined torque, and applying the thus ascertained force
21 to the clutch with attendant automatic selection of the slip
22 between the output and input elements as a function of the
23 factor k_e and compensation for eventual departures from the
24 desired torque transmission, as a function of the correction
25 factor k_{corr} , due to the characteristics of the selected
26 power train.

1 28. A method of operating a torque transmitting
2 apparatus, particularly in a power train of a motor vehicle,
3 which receives torque from a rotary output element of a prime
4 mover, such as a combustion engine, and transmits torque to
5 a rotary input element of an automatic transmission, wherein
6 a hydrokinetic torque converter is arranged to transmit torque
7 between the output and input elements in parallel with a slip
8 clutch, and wherein the magnitude of torque being transmitted
9 by the clutch is selectively variable by a monitoring device
10 in conjunction with a central computer unit, comprising the
11 steps of ascertaining the magnitude of torque M_{clutch} to be
12 transmitted by the clutch in dependency upon the operating
13 condition of the torque transmitting apparatus in accordance
14 with the equation $M_{\text{clutch}} = k_e \cdot k_{\text{corr}} \cdot M_{\text{pm}}$ wherein
15 $k_e = k_{\text{me}}$ denoting a torque dividing factor which is dependent
16 upon the RPM of the output element of the prime mover and
17 the magnitude of torque being transmitted by the output
18 element of the prime mover, k_{corr} is a correction factor
19 and M_{pm} is the torque being transmitted by the prime mover,
20 ascertaining the magnitude of the force to be applied by the
21 clutch for the transmission of a predetermined torque, and
22 applying the thus ascertained force to the clutch with
23 attendant automatic selection of the slip between the output
24 and input elements as a function of the factor k_e and
25 compensation for eventual departures from the desired torque

CLAIM 28, CONTINUED

26 transmission, as a function of the correction factor k_{corr} ,
27 due to the characteristics of the selected power train.

1 29. A method of operating a torque transmitting
2 apparatus which receives torque from a rotary output element
3 of a prime mover, such as a combustion engine, and transmits
4 torque to a rotary input element of an automatic transmission
5 in a power train of a vehicle, wherein a hydrokinetic torque
6 converter is arranged to transmit torque between the output
7 and input elements in parallel with a slip clutch, wherein the
8 magnitude of torque being transmitted by the clutch is variable
9 by a pressure differential between two bodies of a hydraulic
10 fluid one of which is confined in a first compartment between
11 a housing of the torque converter and the slip clutch and the
12 other of which is confined in a separate second compartment
13 between the housing and the clutch, and wherein the pressure
14 differential is variable by a monitoring unit in conjunction
15 with a central computer unit and the application of force to,
16 and hence the magnitude of torque being transmitted by, the
17 clutch is selectively regulatable by the computer unit,
18 comprising the steps of ascertaining the magnitude of torque
19 to be transmitted by the clutch in dependency upon the operating
20 condition of the power train in accordance with the equation

21
$$M_{clutch} = k_e \cdot k_{corr} \cdot M_{pm}$$

CLAIM 29, CONTINUED

22 wherein $k_e = k_{me}$ denoting a torque dividing factor which
23 satisfies at least one of the requirements including (a) at least
24 substantial constancy within the entire operating range of the
25 power train, (b) independence from a characteristic field of the
26 prime mover, (c) dependency exclusively upon the RPM of the
27 output element of the prime mover, and (d) dependency upon
28 the RPM of the prime mover and the magnitude of torque being
29 transmitted by the output element, k_{corr} is a correction
30 factor, M_{clutch} is the torque being transmitted by the clutch
31 and M_{pm} is the torque being transmitted by the rotary output
32 element of the prime mover, ascertaining the magnitude of
33 the force to be applied to the clutch for the transmission
34 of a predetermined torque, and applying the thus ascertained
35 force to the clutch with attendant automatic selection of
36 the slip between the output and input elements as a function
37 of the torque dividing factor k_e and compensation for eventual
38 departures from the desired torque transmission, as a function
39 of the correction factor k_{corr} , due to the characteristics
40 of the selected power train.

1 30. The method of claim 29, wherein the prime mover
2 is a combustion engine the operating condition of which is
3 dependent upon the RPM of the output element and the position
4 of a throttle control lever of the vehicle.

1 31. The method of claim 29, wherein the prime mover
2 is a combustion engine the operating condition of which is
3 dependent upon the RPM of the output element and the subatmospheric
4 pressure in a suction pipe of the engine.

1 32. The method of claim 29, wherein the prime mover
2 is a combustion engine the operating condition of which is
3 dependent upon the RPM of the output element and the duration
4 of fuel injection into the engine.

33. The method of claim 29, further comprising
the step of selecting in the central computer unit that torque
which is to be transmitted by the clutch in response to
changes of the torque being transmitted by the power train
in accordance with the following undertakings: (A) advance
determination of a parameter X which is indicative of the
torque being transmitted by the clutch at an instant t_{n+1} after
the elapse of a monitoring interval and which is ascertained
in accordance with a function excluding at least one undesirable
phenomenon, such as blocking of the clutch, (B) determination
of a gradient ΔX which is required to arrive at a desired
value of the parameter X after elapse of an interval Δt ,
(C) applying the thus determined gradient ΔX with a hydraulic
system including a proportionality regulation wherein a
parameter includes a pressure differential ΔP established
in advance between bodies of a hydraulic fluid at opposite
sides of a pressure plate of the clutch in a housing of
the torque converter in accordance with the equation
$$\Delta P_{n+1} = (1 - \beta) \cdot \Delta P_{\text{desired}} + \beta \cdot P_n$$

wherein $\beta = f(T_v, t)$, and (D) repeating the steps (A),
(B) and (C) until the parameter X at least closely approximates
the desired parameter.

1 34. The method of claim 29, further comprising
2 the step of selecting in the central computer unit that
3 torque which is to be transmitted by the clutch, in response
4 to changes of torque being transmitted by the power train,
5 in accordance with the following undertakings: (A) determining
6 a gradient ΔX of a parameter X which is indicative of the
7 torque being transmitted by the clutch and is ascertained
8 in accordance with a function excluding at least one undesirable
9 phenomenon, such as short-lasting blocking of the clutch,
10 (B) applying the gradient ΔX with a hydraulic system
11 wherein the gradient is indicative of a pressure differential
12 ΔP between two bodies of hydraulic fluid at opposite sides
13 of a pressure plate of the clutch in a housing of the torque
14 converter and is arrived at in accordance with the equation
15
$$\Delta \Delta P = C_1 \cdot (\Delta P_{\text{desired}} - \Delta P_n)$$

16 wherein C_1 is a proportionality factor, and (C) repeating
17 the steps (A) and (B) until the parameter X at least
18 approximates a desired value.

1 35. The method of claim 29, wherein a reduction
2 of torque being transmitted to the torque converter is
3 likely to develop as a result of at least one of a plurality
4 of occurrences including shifting of the transmission into
5 a lower drive ratio and attachment of at least one auxiliary
6 aggregate to an output element of the transmission and
7 wherein said reduction of torque is likely to entail short-
8 lasting blockage of the clutch, further comprising the
9 steps of reducing the magnitude of torque being transmitted
10 by the clutch including at least one of the following unter-
11 takings: (A) reducing the factor k_e by a predetermined value,
12 (B) reducing the factor k_{corr} by a predetermined value, and
13 thereupon gradually increasing each reduced factor as
14 a function of time to a value which ensures insulation
15 of the transmission against vibrations and economical
16 fuel consumption by the prime mover.

36. The method of claim 29, wherein a reduction of torque being transmitted by the apparatus is likely to develop as a result of at least one of a plurality of occurrences including shifting of the transmission into a different drive ratio and attachment of at least one aggregate to an output element of the transmission and wherein said reduction of torque is likely to entail short-lasting blockage of the clutch, further comprising the steps of reducing the magnitude of torque being transmitted by the clutch including at least one of the following undertakings: (A) reducing the factor k_e by a predetermined value, and (B) reducing the factor k_{corr} by a predetermined value, and thereupon increasing each reduced factor as a function of time to a value which ensures insulation of the transmission from vibrations and economical fuel consumption by the prime mover.

1 37. The method of claim 29, wherein the factor
2 k_{corr} is indicative of the selected power train in the vehicle
3 and further comprising the steps of selecting the factor
4 k_{corr} to compensate for eventual departures of the character-
5 istics of the selected power train from desired characteristics
6 including monitoring that slip of the clutch which develops
7 in a predetermined quasi stationary range of operation
8 of the apparatus with a time delay which is sufficient
9 to prevent the transmission of fluctuations of transmitted
10 torque, comparing the monitored slip with a reference value
11 which is selected to ensure optimal insulation of the
12 transmission from vibrations and economical fuel consumption
13 by the prime mover, and altering the slip of the clutch
14 when the monitored slip departs from the reference value.

1 38. The method of claim 29, further comprising
2 the step of reducing at least one of the factors k_e and
3 k_{corr} in response to detected indication of intended
4 acceleration of the prime mover, such as by a change of
5 the position of a throttle control lever of the vehicle,
6 with attendant increase of slip of the clutch and the
7 establishment of additional spare torque transmittable
8 by the torque converter.

1 39. The method of claim 29, wherein the transmission
2 has a plurality of drive ratios and said regulating step
3 comprises utilizing the slip of the clutch at each of said
4 drive ratios as a primary factor and the efficiency of
5 the torque converter as a secondary factor for transmission
6 of torque from the rotary output element to the rotary
7 input element to thus permit the utilization of a torque
8 converter having a wide torque conversion range.

1 40. The method of claim 29, wherein said regulating
2 step comprises utilizing the slip of the clutch at each
3 speed ratio of the transmission as a primary factor and
4 the efficiency of the torque converter as a secondary factor
5 for transmission of torque from the rotary output element
6 to the rotary input element to thus permit the utilization
7 of a torque converter having a wide torque conversion range.

1 41. A method of regulating, as a function of the
2 magnitude of torque, the slip of a friction clutch which
3 transmits torque jointly with a hydrokinetic torque converter
4 to a transmission having a plurality of speed ratios including
5 at least two forward speed ratios, comprising the step
6 of selecting - at least for said forward speed ratios - the slip
7 as a function of at least one of two variable parameters
8 including the energy requirements and the output of the
9 torque transmitting apparatus including the clutch and
10 the torque converter.

1 42. A method of regulating the operation of a
2 driving unit wherein a rotary output element of a combustion
3 engine transmits torque to a hydrokinetic torque converter
4 and to a slip clutch, comprising the step of selecting
5 the slip of the clutch in two stages including a first
6 stage while the output element transmits between about
7 10% and about 60% of a maximum torque capable of being
8 transmitted by the engine and a second stage while the output
9 element transmits torque exceeding the torque being trans-
10 mitted during the first stage.

43. The method of claim 42, wherein the maximum torque transmittable by the slip clutch during said first stage is between at least 1 and 1.2 times the torque being transmitted by the output element of the engine.

44. The method of claim 42, wherein the maximum torque transmittable by the clutch during said first stage at least matches the torque being transmitted by the engine.

45. A method of regulating the operation of a driving unit wherein a rotary output element of a combustion engine transmits torque to a hydrokinetic torque converter and to a slip clutch, comprising the steps of selecting the slip of the clutch in two stages including a first stage while the output element transmits between about 15% and about 50% of a maximum torque capable of being transmitted by the engine and a second stage while the output element transmits torque exceeding the torque being transmitted during the first stage.

1 46. A method of operating a driving unit adapted
2 for use in a motor vehicle and having a variable-speed
3 combustion engine with a rotary torque transmitting output
4 element, a transmission, a hydrokinetic torque converter
5 driven by the output element and arranged to transmit
6 torque to the transmission, and an adjustable slip clutch
7 engageable to transmit torque from the output element to
8 the transmission, comprising the step of adjusting the slip
9 clutch as a function of variations of torque being transmitted
10 by the output element.

1 47. The method of claim 46, wherein the transmission
2 is an automatic transmission.

1 48. The method of claim 47, wherein the automatic
2 transmission is a multi-step transmission.

1 49. The method of claim 47, wherein the automatic
2 transmission is a continuously variable transmission.

1 50. The method of claim 47, wherein the automatic
2 transmission is an infinitely variable transmission.

1 51. The method of claim 47, wherein the automatic
2 transmission is an infinitely variable transmission including
3 sheaves and at least one endless flexible element trained
4 over the sheaves.

1 52. The method of claim 47, wherein the automatic
2 transmission is shiftable into a finite number of drive
3 ratios.

1 53. The method of claim 47, wherein the automatic
2 transmission is shiftable into an infinite number of drive
3 ratios.

54. Apparatus for transmitting torque between
a variable-speed rotary output element of a prime mover
and a rotary input element of a driven unit, comprising
a hydrokinetic torque converter including a housing rotatable
about a predetermined axis, defining a fluid-containing
chamber and receiving torque from the output element, a
pump driven by said housing, a turbine disposed in said
housing and arranged to transmit torque to said input element,
and a stator disposed in said housing between said pump
and said turbine; and a friction clutch having a piston disposed
in said chamber between said turbine and said housing and
comprising a conical radially outer portion movable in
the direction of said axis into and from frictional engagement
with a complementary portion of said housing to thereby
respectively engage and disengage the clutch, said piston
further having a radially inner portion non-rotatably and
sealingly connected with said turbine.

55. The apparatus of claim 54, wherein said radially
inner portion of said piston includes a first hub and said
turbine includes a second hub, one of said hubs being sealingly
and non-rotatably telescoped into the other of said hubs.

1 56. The apparatus of claim 54, wherein said complementary
2 portion of said housing and said radially outer portion
3 of said piston diverge radially outwardly and away from
4 said turbine as seen in the direction of said axis.

1 57. The apparatus of claim 54, further comprising
2 a torsional damper between said clutch and said turbine,
3 said damper including an input member non-rotatably connected
4 with said piston, an output member non-rotatably connected
5 with said turbine, and at least one annular torque transmitting
6 member disposed between said input and output members
7 and acting in a circumferential direction of said piston.

1 58. The apparatus of claim 54, further comprising
2 a torsional damper between said clutch and said turbine,
3 said damper having an output member non-rotatably connected
4 with a radially outer portion of said turbine.

1 59. The apparatus of claim 54, further comprising
2 a torsional damper between said clutch and said turbine,
3 said damper including an annular output member bonded to
4 said turbine and having motion transmitting portions extending
5 toward said radially outer portion of said piston.

1 60. The apparatus of claim 54, further comprising
2 a torsional damper between said clutch and said turbine,
3 said damper including an input member having at least one
4 leaf spring non-rotatably connected with said piston,
5 said radially outer portion of said piston having a friction
6 face confronting a friction face of said complementary
7 portion of said housing and a surface facing away from said
8 friction faces, said damper further having energy storing
9 elements extending circumferentially of said radially outer
10 portion of said piston and said input member further having
11 first projections extending from said surface and at least
12 partially surrounding said energy storing elements and
13 second projections alternating with said energy storing
14 elements in the circumferential direction of said radially
15 outer portion of said piston.

1 61. Apparatus for transmitting torque in a power
2 train between a variable-speed rotary output element of
3 a prime mover and a rotary input element of an automatic
4 transmission installed in a conveyance and having a plurality
5 of speed ratios, comprising a hydrokinetic torque converter
6 receiving torque from said output element and arranged to
7 transmit torque to said input element, said torque converter
8 including a housing receiving torque from said output element
9 and defining a fluid-containing chamber, and a turbine
10 rotatable about a predetermined axis; a slip clutch connected
11 in parallel with said torque converter and including a
12 piston disposed in and dividing said chamber into first
13 and second compartments, said piston being movable in the
14 direction of said axis to thereby engage and disengage
15 the clutch as a result of the establishment of pressure
16 differentials between the fluids in said compartments so
17 that said pressure differentials determine the magnitude
18 of torque being transmitted by said clutch from said housing
19 to said turbine; and means for selecting said pressure
20 differentials for all speed ratios of said transmission
21 as a function of at least one of a plurality of variable
22 parameters, including means for monitoring said at least
23 one parameter, said torque converter having a ratio greater
24 than 2.5.

1 62. The apparatus of claim 61, wherein said at
2 least one parameter is the heat which is generated by the
3 apparatus while the conveyance is in motion and said selecting
4 means includes means for comparing the thus ascertained
5 heat with a predetermined value denoting a maximum permissible
6 heat.

1 63. The apparatus of claim 61, wherein said selecting
2 means includes means for establishing a pressure differential
3 which entails a reduction of heat generation by said clutch
4 in response to detection by said selecting means of at
5 least one of a plurality of circumstances of operation
6 of the conveyance.

1 64. The apparatus of claim 63, wherein said selecting
2 means is operative to select a pressure differential at
3 which said clutch is operated with a minimal slip of said
4 piston and said housing relative to each other except when
5 said at least one circumstance of operation involves starting
6 or acceleration or movement of the conveyance along sloping
7 roads.

1 65. The apparatus of claim 61, further comprising
2 a torsional damper interposed between said piston and said
3 turbine to damp fluctuations of torque being transmitted
4 by said clutch at least when the conveyance is operated
5 at a partial load.

1 66. Apparatus for transmitting torque in a power
2 train between a variable-speed rotary output element of
3 a prime mover and a rotary input element of an automatic
4 transmission installed in a power train of a conveyance
5 and having a plurality of transmission ratios, comprising
6 a hydrodynamic torque converter having a conversion ratio
7 greater than 2.5 and including a housing rotatable by said
8 output element and defining a fluid-containing chamber,
9 and a turbine rotatable in said chamber about a predetermined
10 axis and arranged to transmit torque to said input element;
11 a slip clutch disposed in parallel with said torque converter
12 and including a piston installed in and dividing said chamber
13 into a first compartment for said turbine and a second
14 compartment, said piston being movable in the direction
15 of said axis to thus at least partially engage and disengage
16 the clutch in response to the establishment of different
17 pressure differentials between the fluids in said compartments,
18 said piston having a friction face in contact with a friction

CLAIM 66, CONTINUED

19 face of said housing in the engaged condition of said clutch;
20 and computerized means including a hydraulic circuit between
21 said compartments and operative to select the pressure
22 differential and hence the magnitude of torque being transmitted
23 by said clutch at least at some of said transmission ratios.

1 67. The apparatus of claim 66, wherein said compu-
2 terized means is operative to select the pressure differential
3 as a function of the heat which is generated by the apparatus
4 while the conveyance is in motion and to compare the thus
5 ascertained heat with a predetermined value denoting a
6 maximum permissible heat.

1 68. The apparatus of claim 66, wherein said computerized
2 means includes means for establishing a pressure differential
3 which entails a reduction of heat generation by said clutch
4 in response to detection by a selecting means of said computerized
5 means of at least one of a plurality of extreme circumstances
6 of operation of the conveyance.

1 69. The apparatus of claim 68, wherein said selecting
2 means is operative to select a pressure differential at
3 which said clutch is operated with a minimal slip of said
4 piston and said housing relative to each other except when
5 said at least one circumstance of operation involves starting
6 or acceleration or movement of the conveyance along sloping
7 roads.

1 70. The apparatus of claim 66, further comprising
2 a torsional damper interposed between said piston and said
3 turbine to damp fluctuations of torque being transmitted
4 by said clutch at least when the conveyance is operated
5 at a partial load.

1 71. Apparatus for transmitting torque in a power
2 train between a variable-speed rotary output element of
3 a prime mover and a rotary input element of an automatic
4 transmission installed in a power train of a conveyance
5 and having a plurality of forward transmission ratios,
6 comprising a hydrodynamic torque converter having a conversion
7 ratio greater than 2.5 and including a housing rotatable
8 by said output element and defining a fluid-containing
9 chamber, and a turbine rotatable in said chamber about
10 a predetermined axis and arranged to transmit torque to
11 said input element; a slip clutch disposed in parallel
12 with said torque converter and including a piston installed
13 in and dividing said chamber into a first compartment for
14 said turbine and a second compartment, said piston being
15 movable in the direction of said axis to thus at least
16 partially engage and disengage the clutch in response to
17 the establishment of different pressure differentials between
18 the fluids in said compartments, said piston having a friction
19 face in contact with a friction face of said housing in
20 the engaged condition of said clutch; and computerized
21 means including a hydraulic circuit between said compartments
22 and operative to select the pressure differential and hence
23 the magnitude of torque being transmitted by said clutch,
24 said clutch being at least partly engaged at least during
25 a portion of the interval of operation of the transmission
26 at any one of said forward ratios.

1 72. Apparatus for transmitting torque in a power train
2 between a variable-speed rotary output element of a prime mover
3 and a rotary input element of an automatic transmission installed
4 in a power train of a conveyance and having a plurality of
5 forward transmission ratios, comprising a hydrodynamic torque
6 converter arranged to transmit torque between said elements;
7 a slip clutch disposed in parallel with said torque converter
8 and being engageable to transmit torque from said output
9 element to said input element; and means for regulating
10 the slip of said clutch in each forward ratio of said trans-
11 mission as a function of at least one of a plurality of
12 variable parameters including the energy requirements and
13 the output of the torque transmitting apparatus.

1 73. A driving unit comprising a combustion engine having
2 a rotary output element for transmission of torque including
3 a nominal torque; a hydrokinetic torque converter receiving
4 torque from said output element; a slip clutch engageable to
5 transmit torque from said output element; and a torsional
6 damper disposed between said clutch and said torque converter
7 and having a capacity for transmission of torques at most
8 matching said nominal torque.

1 74. The driving unit of claim 73, wherein a maximum
2 torque transmittable by said damper is between about 10% and
3 about 60% of a maximum torque transmittable by said engine.

1 75. The driving unit of claim 73, wherein a maximum
2 torque transmittable by said damper is between about 25%
3 and about 50% of a maximum torque transmittable by said
4 engine.

1 76. The driving unit of claim 73, wherein said
2 damper is devoid of friction generating means.

1 77. The driving unit of claim 73, wherein said
2 damper includes rotary input and output members turnable
3 relative to each other through angles of between about
4 $\pm 2^\circ$ and about 8° .

1 78. The driving unit of claim 73, wherein said
2 damper includes rotary input and output members turnable
3 relative to each other through angles of between about
4 $\pm 3^\circ$ and about 6° .

1 79. The driving unit of claim 73, wherein said
2 damper has a rigidity of between about 7 Nm/° and about
3 30 Nm/°.

1 80. A driving unit comprising a combustion engine
2 including a torque transmitting rotary output element; a
3 hydrokinetic torque converter receiving torque from said
4 output element; a slip clutch engageable to transmit torque
5 from said output element; and a torsional damper between
6 said clutch and said torque converter, said damper being
7 operative to damp eventual fluctuations of torque being
8 transmitted by said output element within a first range of
9 magnitudes of torque being transmitted by said output element
10 and said clutch being operative to damp eventual fluctuations
11 of torque being transmitted by said output element within
12 a different second range of magnitudes of torque being
13 transmitted by said output element.

1 81. The driving unit of claim 80, wherein said clutch
2 is adjustable to transmit torques of varying magnitude, and
3 further comprising means for reducing the torque transmitting
4 capacity of said adjustable clutch within said first range in
5 response to high-frequency fluctuations of torque.

1 82. The driving unit of claim 81, wherein said
2 means for reducing the torque transmitting capacity of said
3 clutch is responsive to high-frequency fluctuations of torque
4 developing as a result of resonance and abrupt changes of
5 load upon said engine.

1 83. The driving unit of claim 80, wherein said damper
2 has a capacity for transmission of a maximum torque when the
3 magnitude of torque being transmitted by said output element
4 is at least close to an upper limit of said first range.

1 84. The driving unit of claim 80, wherein the
2 minimum torque being transmittable by said clutch at least
3 during a portion of said second range exceeds about 1% of a
4 nominal torque being transmittable by said output element.

1 85. The driving unit of claim 80, wherein said
2 clutch is adjustable and further comprising means for adjusting
3 said clutch for the transmission of at least substantially
4 constant torque at least within a portion of said second range
5 of magnitudes of torque being transmitted by said output
6 element.

1 86. The driving unit of claim 80, wherein the
2 rotational speed of said output element is between an idling
3 RPM of the engine and approximately 3000 RPM within said first
4 range of magnitudes of torque being transmitted by said output
5 element.

1 87. The driving unit of claim 80, wherein the
2 rotational speed of said output element is between an idling
3 speed of the engine and between about 2000 RPM and about
4 2500 RPM within said first range of magnitudes of torque
5 being transmitted by said output element.

1 88. The driving unit of claim 80, wherein the
2 magnitude of torque being transmitted within said second
3 range of magnitudes of torque being transmitted by said output
4 element is between about 0.6 and 1.0 times the torque being
5 transmitted by said output element.

1 89. The driving unit of claim 80, wherein the
2 magnitude of torque being transmitted by said output element
3 within said second range is between about 0.8 and about 0.9
4 times the torque being transmitted by said output element.

1 90. The driving unit of claim 80, wherein said
2 engine has a main operating range and at least a major part
3 of the characteristic field of the engine which is utilized
4 within said main operating range coincides with said first
5 range of magnitudes of torque being transmitted by said
6 output element.

1 91. The driving unit of claim 90, wherein said
2 characteristic field includes at least one of (a) those
3 zones of the characteristic field which are relevant for the
4 FTP75-cycle and (b) those zones which are relevant for the
5 ECE cycle [city 90 kilometers per hour, 120 kilometers per
6 hour].

1 92. A driving unit for a vehicle, comprising a
2 combustion engine; means for accelerating said engine;
3 a transmission shiftable between a plurality of progressively
4 higher drive ratios; a hydrokinetic torque converter driven
5 by said engine and arranged to transmit torque to said trans-
6 mission; a slip clutch engageable to transmit torque from said
7 engine to said transmission; means for monitoring the
8 transmission of torque by said clutch and said torque converter
9 at least during acceleration of said engine; and means
10 (a) for disengaging said clutch when such disengagement
11 within any one of said drive ratios entails an increase of
12 the pulling force of the vehicle as a result of torque
13 conversion, and (b) for shifting the transmission to a lower
14 drive ratio when the disengagement of the clutch does not
15 entail an increase of said pulling force.

1 93. A driving unit for a vehicle, comprising a
2 combustion engine; means for accelerating said engine;
3 a transmission shiftable between a plurality of progressively
4 higher drive ratios; a hydrokinetic torque converter driven by
5 said engine and arranged to transmit torque to said transmission;
6 a slip clutch engageable to transmit torque from said engine
7 to said transmission; means for monitoring the transmission of
8 torque by said torque converter and said clutch; and means
9 for (a) disengaging said clutch when such disengagement at a
10 given ratio of said transmission entails an increase of
11 the pulling force of the vehicle, and (b) for shifting
12 the transmission to a different drive ratio when the
13 disengagement of the clutch at said given ratio of said
14 transmission does not entail an increase of said pulling
15 force.

1 94. A driving unit for a motor vehicle, comprising a com-
2 bustion engine having a rotary variable torque transmitting output
3 element; a transmission; a hydrokinetic torque converter
4 driven by said output element and arranged to transmit torque
5 to said transmission; an adjustable slip clutch which is
6 engageable to transmit torque from said output element to
7 said transmission; and means for adjusting the slip of said
8 clutch as a function of variations of the torque being
9 transmitted by said output element.

1 95. The driving unit of claim 94, wherein said
2 transmission is an automatic transmission.

1 96. The driving unit of claim 95, wherein said
2 automatic transmission is a multi-step transmission.

1 97. The driving unit of claim 95, wherein said
2 automatic transmission is a continuously variable transmission.

1 98. The driving unit of claim 95, wherein said
2 automatic transmission is an infinitely variable change speed gear..

1 99. The driving unit of claim 95, wherein said
2 automatic transmission is an infinitely variable transmission
3 including sheaves and at least one endless flexible element
4 trained over said sheaves.

1 100. The driving unit of claim 95, wherein said
2 automatic transmission is shiftable to a finite number of
3 discrete drive ratios.

1 101. The driving unit of claim 95, wherein said
2 automatic transmission is shiftable into an infinite number
3 of drive ratios.